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GRIPPING ELEMENT FOR CONTINUOUS MOTION INSERTING FINGER

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from and is related to U.S. Provisional Application No. 60/462,338, filed April 14, 2003, entitled "GRIPPING ELEMENT FOR CONTINUOUS MOTION INSERTING FINGER", by inventors Bradford D. Henry et al., (Attorney Docket No. 63288-547). The contents of the provisional application are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

A method and a device for conveying and pushing one or more sheets of paper or folded inserts into an envelope are provided, and more particularly a pusher finger guide conveying and pushing one or more sheets of paper or folded inserts into an envelope in a continuous motion system is provided.

BACKGROUND

The use of chain or belt mounted pusher elements is well known in the art of paper handling. Such pushers are used to push a sheet, group of sheets, or folded insert from an upstream position, down a guide path, and into an envelope, which is typically held stationary for an instant to permit insertion of the sheet, group of sheets, or folded insert.

One conventional device, disclosed in U.S. Patent No. 6,283,276, assigned on its face to Bell & Howell Mail and Messaging Technologies Co. of Durham, NC, and incorporated herein

by reference in its entirety, utilizes two side-by-side overhead pusher finger guides or pushers used in tandem so that the insert (whether a flat or folded sheet or group of sheets) received at the upstream position will not skew prior to or at the time of insertion of the insert into the waiting envelope. Another conventional chain-driven device, disclosed in U.S. Patent No. 5,806,659, also assigned on its face to Bell & Howell Mail and Messaging Technologies Co. of Durham, NC, and incorporated herein by reference in its entirety, utilizes a lightweight chain apparatus bearing a plurality of spaced-apart pusher members attached to the chain and a guide element intended to improve dimensional stability of the pusher members.

A conventional overhead conveyor 10 in accord with U.S. Patent No. 6,283,276 is depicted in FIG. 1. First and second circular drive members, such as sprockets 15, 20, are mounted on rotatable drive shafts 16, 17, respectively. Sprockets 15, 20 are positioned such that the X axis is tangent to the lowermost point of each of sprockets 15, 20 and, therefore, the lowermost point of each of sprockets 15, 20, lie along the same point of the Z (vertical) axis. Drive shaft 16 is connected to drive motor 25, and endless conveyor chain 30 is wrapped around the teeth of sprockets 15, 20 and comprises upper conveyor chain run 30a and lower conveyor chain run 30b. Slack in upper conveyor chain run 30a is prevented by use of one or more idler sprockets 32, 34 and, with suitable positioning thereof, lower conveyor chain run 30b will be parallel to the X axis, which itself is parallel to the downstream paper feed direction F. Alternatively, overhead conveyor 10 may be an endless belt-based conveyor, in which case, the circular drive members would comprise pulleys.

A plurality of pusher elements 40 are attached to conveyor chains 30 at a fixed spaced-apart distance. Each pusher element has a lower portion 40a for supporting the bottom of a

sheet(s) and an indented portion 40b for receiving the rear portion of sheet(s) and pushing the same in paper feed direction F. To control the degrees of freedom of movement allowed of pusher 40, a guide 100 is provided for assuring pusher element 40 moves only in the X direction with no deflection in the Y or -Z directions. Guide 100 comprises a guiding element 50 of a selected cross-sectional shape (e.g., a circular cross-section). Sidewalls 42 of the pushers 40 are configured to straddle the respective guiding element 50.

Motor 25 drives conveyor chain 30 and guide elements 40 (rigidly fixed to endless conveyor chain 30) in the counter-clockwise direction through drive shaft 16 and sprockets 15, 20.

At the beginning of a feed cycle for an incoming sheet or plurality of sheets or folded sheet of plurality of sheets in direction F, pusher element 40 on an upper run 30a of endless conveyor chain 30 starts to pass downwardly around sprocket 20 and approaches guide element 50 of guide 100 at the bottom half of sprocket 20. The sidewalls 42 of pusher element 40 start to receive therebetween (e.g., straddle) guide element 50, and thereafter a horizontal cross wall 39 of pusher element 40 comes into contact with the top of guide element 50. Once pusher element 40 passes around sprocket 20 and into lower run 30b of endless conveyor chain 30, indented portion 40b of pusher element 40 contacts the sheet and pushes it in direction X (paper feed direction F) until it reaches a designated release point (not shown), at which time the sheet S is released and pusher element 40 moves upwardly around sprocket 15 and out of engagement with guide element 150 to permit repetition of the cycle.

Despite the improvements realized by the above configuration, there still remains room for improvement in the art, particularly given the movement of sheets, packets, or inserts under

increasingly large accelerations and speeds, both absolute and differential or relative, despite the above-noted improvements to the dimensional stability of the pushers. Thus, there exists a need for a pusher finger guide that reduces opportunity for sheet skew.

SUMMARY

This need is met by the pushing member bearing a gripping element disclosed herein, of which various exemplary aspects thereof are set forth to impress upon one skilled in the art the broad scope of the invention.

In one example, there is provided an envelope insert conveyor assembly includes a first pair of rotation members and a second pair of rotation members spaced apart from one another. A first conveying member is disposed around the first pair of rotation members and a second conveying member is disposed around the second pair of rotation members to so as to rotate around the first rotation member and the second rotation member. A plurality of pusher members are fixed to each of the first conveying member and second conveying member. The pusher members each have paired sidewalls, a cross-wall connecting the paired walls, and an indented portion provided in each of the paired sidewalls. A gripping element is disposed adjacent an indented portion of one of the paired sidewalls and biased toward an interior surface of the indented portion.

In another example, there is provided a pusher member for conveying an envelope insert, comprising paired sidewalls and a cross-wall connecting the paired walls. Each of the paired sidewalls comprises, at a proximal end, downwardly protruding extensions comprising an attachment member. Each of the paired sidewalls also comprises a forwardly disposed generally

U-shaped indented portion, wherein one of the generally U-shaped indented portions comprises a gripping element having a gripping member which is resiliently biased toward an interior surface of the indented portion.

Other aspects and advantages of the present disclosure will become apparent to those skilled in this art from the following description of preferred aspects taken in conjunction with the accompanying drawings. As will be realized, the disclosed concepts are capable of other and different embodiments, and its details are capable of modifications in various obvious respects, all without departing from the spirit thereof. Accordingly, the drawings, disclosed aspects, and description are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference is made to the attached drawings, wherein elements having the same reference numeral designations represent like elements throughout, and wherein:

FIG. 1 of the drawings is a perspective view of a conventional pusher guide assembly;

FIG. 2 of the drawings presents perspective views of a left and a right pusher guide assembly in accord with the present embodiment;

FIG. 3 of the drawings presents a perspective view of a pusher guide assembly attached to a drive chain in accord with the embodiment;

FIG. 4 of the drawings shows a top view of a pusher guide assembly in accord with the embodiment and a cross-sectional view thereof taken along line B-B.

FIG. 5(a) of the drawings shows a front cross-sectional view taken along line A-A of FIG. 5(b), which presents a perspective side of a pusher guide assembly in accord with the embodiment;

FIGS 5(c)-5(d) of the drawings show a front and a rear view of a pusher guide assembly in accord with the embodiment;

FIGS. 6(a)-6(c) of the drawings show a resilient gripper of a pusher guide assembly in accord with the embodiment;

FIG. 7 of the drawings shows a perspective view of an implementation of a pusher guide assembly in accord with the embodiment, used in an envelope package insertion device;

FIG. 8 of the drawings shows a side view of the pusher guide assembly in accord with the embodiment, used in an envelope package insertion device of FIG. 7.

FIG. 9 of the drawings shows a perspective view of the pusher guide assembly in accord with the embodiment, showing the relation between the upper package insertion device and a top plate of a lower envelope conveying device.

FIG. 10 of the drawings shows a side view of the pusher guide assembly in accord with the embodiment, showing the relation between the upper package insertion device and the lower envelope conveying device.

DETAILED DESCRIPTION OF THE DRAWINGS

With reference to the attached drawings, an overhead pusher finger guide system comprising a gripping element for gripping an insert will now be described, with respect to an exemplary and non-limiting preferred embodiment.

FIG. 2 depicts a set of left and a right pusher elements 140, each bearing a resilient gripping member 150 in accord with the inventive disclosure. The pusher elements 140 are, in one aspect, made of a Nylatron GS material. The gripping member 150 is, in one aspect, made from a stainless steel, such as a #300 series. More advantageously, it is preferred that the gripping member 150 (e.g., a stainless steel) be coated with a suitable low-friction coating (e.g., a 95% PEEK/5% PFTE powder coating for application to stainless steel) on a lower portion thereof to reduce friction. Such coating would, in one aspect, have a thickness between about 0.38mm - 0.51mm, but could have a greater or lesser thickness. Alternatively, other lower friction coatings, known to those of ordinary skill in the art, could be employed.

FIG. 3 shows one such pusher element 140 bearing a resilient gripping member 150 attached to a conveyor chain 130. In one aspect, the attachment means includes a set of downwardly protruding extensions 143 that correspond in shape and spacing to the outermost chain link elements 131. The outermost chain link elements 131 are removed and the downwardly protruding extensions 143 are substituted in place thereof.

In one aspect, a plurality of such pusher elements 140 are attached to the conveyor chain at a spaced-apart distance, which may be a fixed distance. Each pusher element has a lower portion 140a for supporting the bottom of a sheet or sheets, a packet, or a folded sheet or sheets (collectively referred to hereinafter as "insert" for brevity). An indented portion 140b is configured to receive a rear portion of the insert and push the same in a feed direction for insertion into an envelope.

As shown in FIG. 3, a supporting member 141 is attached to the conveyor chain 130 behind the pusher element 140. In one aspect, the attachment means includes a set of

downwardly protruding extensions 144 that correspond in shape and spacing to the outermost chain link elements 131. The outermost chain link elements 131 are removed and the downwardly protruding extensions 144 are substituted in place thereof.

Supporting member 141 comprises a generally H-shaped element having two upwardly directed walls 145 and a horizontal cross-wall 146. The upwardly directed walls 145 comprise forward projections 147 that engage corresponding recesses 148 in the pusher element 140 when the conveyor chain 130 is substantially horizontal and disengage from the recesses 148 in the pusher element 140 when the conveyor chain 130 deviates from the substantially horizontal, such as when the conveyor chain 130 is passed about at least a portion of a circumference of a gear or sprocket. The combination of the supporting member 141, forward projections 147 and pusher element 140 recesses 148 provide increased rigidity to the pusher element 140, and therefore a greater degree of stability to the pusher element 140 and any object carried thereby. Although the depicted recesses 148 and forward projections 147 are provided approximately mid-way up the height of pusher element 140 sidewalls 142, this particular configuration is not required and the recesses 148 and forward projections 147 may be provided either higher or lower relative to the pusher element 140 sidewalls 142 in accord with the embodiment.

As shown in greater detail in FIGS. 5(a) and 5(b)-5(c), pusher element 140 comprises a generally H-shaped element having sidewalls 142 and a horizontal cross-wall 139. A portion of sidewalls 142 proximal to the conveying means, such as endless conveyor chain 130, are configured for attachment to the conveying means. As illustrated in FIG. 3, holes 160 are provided in sidewalls 142 to permit connection (such as by pinning 161, adhesives, bonding, or suitable welding techniques) of the sidewalls 142 to elements 143 which replace the outermost

elements 131 of a conveying chain 130. Alternately, sidewalls 142 themselves may be formed for direct connection to the chain 130.

Gripping member 150, an embodiment of which depicted in FIGS. 5(a) and 5(b), comprises a pivot arm mounted for rotation about a pivot point formed by a pin 170 inserted through corresponding holes in a forward portion of the pusher element 140. Pin 170 may be, for example, a McMaster-Carr #90145A414. The pivot point generally defines an upper end of the pivot arm above the pivot point or pin 170 and a lower end of the pivot arm below the pivot point or pin 170. In one aspect, illustrated in detail in FIGS. 6(a)-6(c), the lower end of the gripping member 150 pivot arm has a curved lower portion 176 configured to contact an upper inner surface of pusher element 140 lower portion 140a so as to prevent continued rotational movement of the pivot arm gripping member 150 in a counter-clockwise direction past the lower portion 140a. A distal end of the curved lower portion 176 optionally curves upwardly away from pusher element 140 lower portion 140a to prevent contact of the edge of the curved lower portion from the insert received within indented portion 140b.

In alternative embodiments, gripping member 150 may comprise a pivot arm with a straight lower portion, an angled lower portion, or a ball disposed at the lower end of the pivot arm, for example. In still further alternative embodiments, a degree of rotation of the gripping member 150 pivot arm may be regulated by mating protrusions and/or combinations of protrusions and recesses on or in the gripping member 150 and inner surface of sidewalls 142.

On an upper end of the gripping member 150 pivot arm, above the pin 170, is a hole 175 through which one end of a conventional tension spring 180 having looped ends is engaged. The opposite end of spring 180 is attached to sidewall 142 by a pin inserted through a through-hole

165. As shown in FIG. 2, the opposite end of spring 180 enters a hole 185 in the forward edge of sidewall 142, the spring diameter being selected to be accommodated within said hole. The spring may include, for example, a Lee Spring # EI-011B-2-M, possessing a 2.38 mm outside diameter (OD). This spring, in combination with the embodiment depicted in FIGS. 2-6(c), provides a downwardly biased force against an insert of about 0.069 lb. at a zero position (i.e., in contact with the lower portion 140a of pusher member 140 and imparts a force of about 0.135 lb at full extension. Other arrangements and springs could be employed in accord with the embodiment to generate higher or lower downwardly biased forces, as appropriate to suitably engage and temporarily retain the inserts of interest to a particular application. Alternate springs include, but are not limited to Lee Spring Nos. EI-008A-1-M, EI-008A-2-M, EI-009A-2-M, and EI-009A-1-M, for example. The pin inserted through through-hole 165 may be, for example, a McMaster-Carr #90145A414.

In one aspect, gripping member 150 is provided to pivot inwardly when an object, such as the aforementioned insert, encounters the leading or forwardmost edge of the lower end of the pivot arm. This inward pivoting motion exposes a height-wise portion of the indented portion 140b sufficient to receive an insert, which could comprise a range of thickness. An assist member comprising one or more rollers (e.g., elastomeric rollers)(see FIG. 9) may be provided, at an upstream (upper left side) of the continuous motion inserting machine 180 depicted in FIG. 7, which lightly press down upon an insert to control the insert as the insert travels forward and into position for engagement with pusher member indented portion 140b and gripper means 150. The forward motion imparted to the insert is provided by interface pins acting on a back side of the insert over a portion of the insert feed path up to the point at time in which the pusher

members 140 engage and carry the insert. The interface pins are disposed to travel in a feed direction of the insert while acting along the back side of the insert at a location which will not interfere with the motion of the pusher elements. The pusher elements travel along a path in which they descend from above and behind the moving insert to engage a back side of the insert as it travels forward.

In another aspect, an assist member (not shown) may be provided along the path of travel of the pusher member 140 so as to impart a force to a forward or leading edge of the pivot arm immediately prior to contact of the pivot arm by the insert to slightly bias the pivot arm inwardly to facilitate entry of the insert (i.e., an edge thereof) into the indented portion 140b.

It is noted that alternative arrangements of pivot points and spring types are contemplated as being within the scope of the embodiment. For example, the leading portions of pusher member 140 could be configured to receive a helical torsion spring acting either about the pivot point of the gripping member 150 or displaced therefrom depending upon the terminus configuration of the torsion spring. Additional configurations within the scope of the present concepts could employ a compression spring acting below the pivot point of the gripping member 150 to provide a biasing force against inward movement of the lower end of the gripper means 150 into the indented portion 140b. Still further configurations within the present concepts could employ a vertically translatable gripping member, such as the aforementioned pivot arm or even a lightweight roller ball or wheel configured to provide, in combination with a suitably placed spring (e.g., a tension or compression spring), a desired downward force against the pusher member 140 upper inner portion of lower portion 140a. In such a configuration, the vertically translatable gripper means 150 may be configured to co-act with a guide placed along

and adjacent the path of travel of the pusher member 140 to provide the motive force for vertical displacement of the gripper means. In other words, the guide could force the gripper means 150 from a first state to a second state as the pusher element 140 travels across the guide.

During forward or downstream conveyance of the insert, the gripping member 150 provides a downward force biasing the insert against the pusher member 140 lower portion 140a to ensure that the insert does not slip relative to the pusher member 140.

An aspect of an apparatus in which the pusher members may advantageously be utilized is shown in FIGS. 9-10. As shown in FIGS. 9-10, for example, the movement of an envelope is denoted by an arrow E passing upwardly between lower plate 300 and upper guide plate 310 and the movement of pusher member 140 is also denoted by an arrow. In one aspect, as pushing member 140 arcs around sprocket 120, as shown in FIGS. 9-10, pushing member 140 encounters and retains an insert (not shown) provided thereto by an appropriate insert feed device prior to passage beyond upper guide plate 310.

The envelope is conveyed in a position wherein the leading edge of the envelope is the bottom edge of the envelope and the open flap of the envelope is the trailing edge with the open flap being on the bottom (i.e., the envelope is face-down). Although not shown, the envelope is stopped, for a few milliseconds, by a registration stop acting in concert with lower plate 300. A vacuum may then be imparted by upper and lower vacuum members (not shown), during the fleeting registration of the envelope, to both the upper and lower sides of the envelope to partially open the envelope and prepare the envelope for receipt of the insert carried by pusher members 140. As the envelope is held in the partially open position by the vacuum members, inserting fingers 210, which may in one aspect be shaped in a substantially "taco-like" form, arc

around cams 400, 410 in a clockwise direction (as viewed from above) and approach the partially open envelope from the rear in the vicinity of a beginning portion 215 of the envelope travel path within the insertion device.

As the inserting fingers 210 approach and engage the left and right sides of the envelope, the outer surfaces of the inserting fingers 210 (e.g., outer surfaces of the "taco") further open and/or retain the open position of the envelope as an upper vacuum member is disengaged from the envelope back surface, which is face-up. The lug 211 of the inserting fingers abuts against the left and right top edges of the envelope and continued motion of the continuously moving inserting fingers 210 starts to push the envelope forward. Substantially simultaneously with the engagement of the envelope by the inserting fingers 210, the pushing members 140 bearing the insert approach an inner surface of the inserting fingers 210 tangentially as the inserting fingers 210 arc around cams 400, 410 and the outer leading edges of the insert engage inner surfaces of the around cams 400, 410 (e.g., inner surfaces of the "taco") which support and/or guide the insert into place within the envelope, which in one aspect may already be moving by virtue of the inserting fingers 210. The lower vacuum may advantageously be maintained as the envelope continues its downstream travel so as to provide a backforce to facilitate insertion of the insert into the envelope. At some point during the insertion of the insert into the envelope, preferably when the insertion is at least substantially complete, the forward motion of the pusher members 140 removes the stuffed envelope from the insertion fingers 210 (e.g., the velocity of the pusher member 140 is greater than that of the insertion fingers 210).

Proper alignment of the pusher member 140 and the insert, realized in one example by the structure described and depicted herein, enables accurate insertion of the insert into the envelope and is further assisted by the inner surface of the inserting fingers.

Once the insert has been conveyed into the envelope, the combined envelope and insert is then accelerated away from pusher member 140. In one aspect, this disengagement of the combined envelope and insert from the pusher members 140 is achieved by utilizing a powered (e.g., motor-driven) roller cylinder or drum or a belt provided over a roller cylinder or drum, with one component of the belt driven systems being powered (e.g., motor-driven)(hereinafter simply "drum"), disposed under the path of the filled envelope, rotating such that an outer circumference of the drum is moving in the downstream direction at a velocity greater than that of the filled envelope and pusher member 140 immediately upstream of the drum. A stabilizing roller device is disposed above the path of the filled envelope and above the centerline of the drum to provide a slight downwardly biasing force to stabilize the filled envelope as it is accelerated by the rotating drum. The stabilizing roller device may comprise one or more vertically translatable elements, such as passive or reactive rollers disposed on a pneumatic, hydraulic, or solenoid powered piston. Alternatively, the stabilizing roller device may comprise rollers configured to rotate at a predetermined velocity matching that of the rotating drum. Still further, the stabilizing roller device may comprise a substantially stationary drum configured to permit setting of the drum at one of a plurality of preselected displacements from the centerline of the lower drum so as to provide a predetermined gap therebetween corresponding substantially to the thickness of filled envelopes conveyed therethrough. The combination of the rotating drum and the stabilizing roller device are configured, in combination, to accelerate both the envelope and the

insert disposed therein away from the pusher member 140 such that the insert is pulled away from the gripping member 150 in a controlled manner. The orientations of the rotating drum (or belt) and the stabilizing roller device may also be reversed.

It is noted that other devices and methods may be used to disengage the insert (and envelope bearing the insert) from the pusher member 140 gripping member 150. For example, another gripping element or plurality of gripping elements could grip the envelope (and insert borne therein) and accelerate the insert away from the pusher member 140 gripping member 150.

FIGS. 7 and 8 depict one embodiment of a continuous motion inserting machine 180 in which the aforementioned pusher members 140 are utilized. A plurality of pusher members 140 are arranged at predetermined intervals along a drive chain (not shown) provided around sprockets 115, 120, 132 and 134. Two such drive chains are provided and are disposed at substantially equal distances from a center of the device, indicated generally by center member 200. As depicted in FIG. 7, the pusher members 140 are driven in a counter-clockwise direction toward an upper left-hand portion of FIG. 7, where they engage sprocket 120 and are rotated downwardly to a bottom portion of the continuous motion inserting machine 180. The sidewalls 142 of the pusher members 140 are positioned to straddle guide member 250 in a manner similar to that disclosed in U.S. Patent No. 6,283,276, incorporated herein by references in its entirety. Guide member 250 is substantially rectangular and optionally possesses chamfered or angled portions extending along a longitudinal direction of the guide member on upper surfaces thereof.

The downwardly directed indented portions 140b of the pusher elements 140 are positioned, by virtue of guide 250, to receive an insert.

The above description is given with reference to an overhead pusher finger guide system,

wherein the pusher members comprise a gripping member. However, it will be understood that various details may be changed without departing from the broad outlines of the scope of the invention provided herein. Furthermore, the foregoing description is for purpose of illustration only, and not for purpose of limitation. The dimensions indicated in the appended Figures are for illustrative purposes only and may be readily varied to suit different applications and environments. For example, the spacing between the sidewalls 142 may be increased or decreased to accommodate wider or narrower chain or driving means configurations. The height of the sidewalls 142 and placement of the pusher member 140 lower end 140a may be adjusted to suit different configurations of guide member 250 and/or insert placements. As noted above, the gripping member configuration may be adapted in a myriad of ways to achieve the desired result of providing a slight downward force on an insert received within the indented portion 140b of the pusher member 140, which incidentally may be configured to be shallower or deeper, as desired for the particular configuration of equipment. Supporting member 141 may be optionally omitted. Finally, pusher member 140 may comprise lightweight, durable materials other than Nylatron GS, such materials being known or easily ascertained by one of ordinary skill in the art.